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Veling, Harm; Aarts, Henk

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Harm Veling, Henk Aarts

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Running head: WITHHOLDING BEHAVIOR DECREASES REWARD VALUE

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Harm Veling

Henk Aarts

Utrecht University

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Address correspondence to:

Harm Veling
Department of Psychology
Utrecht University
PO Box 80.140
3508 TC Utrecht
The Netherlands
e-mail: h.veling@uu.nl

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Abstract

We examined whether cues that put impulsive behavior towards rewarding objects on hold reduces the value of the rewarding objects outside of conscious awareness. We manipulated the reward value of water by making participants thirsty, or not. Next, a bottle of water was subliminally presented in a go/no-go task, and paired with either go cues or no-go cues (putting behavior on hold). Subsequently, as a measure of reward value of water, participants estimated the size of water objects. Results showed that repeatedly withholding behavior towards water reduced the perceived size of water objects, but only when participants were made thirsty. These results suggest that withholding impulsive behavior towards objects that serve basic needs nonconsciously reduces reward value of these objects. Implications for nonconscious behavior regulation are briefly discussed.

Putting behavior on hold decreases reward value of need-instrumental objects outside of awareness

An important component of effective behavior regulation involves the ability to detect rewarding objects in the immediate environment that are relevant to act on for online needs (Bruner, 1957). Indeed, research has shown that such objects are encoded more efficiently (Aarts Dijksterhuis, & de Vries, 2001), draw more attention (e.g. Channon & Hayward, 1990; Papies Stroebe, & Aarts, in press; Moskowitz, 2002), and are perceived as larger (Brendl, Markman, & Messner, 2003; Bruner & Goodman, 1947; Veltkamp, Aarts, & Custers, in press), in order to facilitate spontaneous preparation to act on these objects. An interesting unanswered question, however, is what happens when utilization of such relevant rewarding objects is (temporarily) inappropriate. For example, when being thirsty, a bottle of water may spontaneously receive priority in attention and action, but when one suddenly notices that this bottle is unavailable (e.g. the bottle belongs to someone else), and spontaneous preparation of impulsive action should be withheld, this prioritization is no longer desirable. That is, the bottle loses its rewarding function to quench thirst.

In the present research we examine whether value of a need-induced rewarding object (Ferguson & Bargh, 2004) is spontaneously decreased in such instances, even in the absence of awareness of the influence, and effect, of the input. This regulation of impulsive behavior without awareness may be highly efficient, because priority can then be given to other, attainable stimuli to reduce ones need, without taxing conscious attention with explicit intentions to refrain from acting on the objects or treat them as less desirable (as is mostly done in research on behavior regulation of undesired impulsive behaviors to rewarding objects; Baumeister, Vohs, & Tice, 2007; Carver, 2005; Gollwitzer 1999; Metcalfe & Mischel, 1999).

Support for this assumption can be derived from research by Veling, Holland, and van Knippenberg (2008) who have shown that when cues to withhold behavior are incidentally activated together with presentation of positive objects, i.e. by pairing positive pictures to no-go cues in a go/no-go task, the subjective positive valence of these objects is decreased. To account for this effect, Veling, Holland, et al. argued that withholding behavior towards positive (or rewarding) objects results in a response conflict (i.e. between preparation to act elicited by the rewarding object - e.g. Chen & Bargh, 1999 -, and a cue that puts behavior on hold; see also Veling, Aarts, & Papies, 2008) which needs to be resolved to continue behavior. By decreasing the value of a (temporarily) unavailable rewarding object, inhibition can be released, and a new course of action can be sought without running the risk that an individual is caught in continuous oscillation between getting ready to act, spontaneously elicited by the visible rewarding object, and inhibiting this preparation. Consistent with this interpretation, reduction of reward value by cues that put behavior on hold did not emerge when the objects were relatively neutral (i.e. for objects that do not prepare action).

The findings discussed above suggest that value of rewarding objects can be incidentally attenuated by cues that signal that acting on the objects is inappropriate, even without forming explicit intentions to do so. In the present research we aim to offer an important, and crucial, extension of this work by examining whether cues that put behavior on hold, accompanied by instrumental objects that serve *basic needs*, decreases value of these objects *outside of awareness*. Such a test would provide direct evidence for the idea that behavior can be regulated nonconsciously.

To test this idea, we experimentally increased the rewarding value of water by making participants thirsty or not (Ferguson & Bargh, 2004; Veltkamp, Aarts, & Custers, 2008). Next, participants were presented subliminally with a bottle of water in a go/no-go task. We repeatedly paired this bottle with either no-go cues (environmental signals that behavior should be withheld), or go cues. Following up on recent advances on the role of basic perception in motivation and goal-directed behavior (Balcetis & Dunning, 2006; Proffitt, 2006; Veltkamp et al., in press), we subsequently measured value of water objects with a size perception task. Size perception of objects is strongly related to rewarding value of objects, and has been shown to be sensitive to implicit processes of rewards (Bruner, 1957; Veltkamp et al., in press). Rewarding objects are perceived as larger, which facilitates the ease with which such objects can be identified in the environment (Bruner, 1957). Hence, we expected that thirsty participants would perceive the water objects as larger than non-thirsty participants, as these objects represent instrumental rewards for them (Veltkamp et al., in press). More importantly, we expected that repeated co-occurrence of water with hold cues would decrease the perceived size of the water objects, but only for thirsty participants, as only for them hold cues conflict with the impulse towards water.

Method

Participants and design

This experiment included 66 undergraduates (41 females). We employed a 2(thirsty: no vs. yes) by 2(pairing of bottle of water: go condition vs. no-go condition) between subjects design.

Procedure

After receiving informed consent, participants were told that they would take part in several unrelated tasks on a computer. Participants worked in separate cubicles in which the experiment was presented on a computer with a 100-Hz screen (800 X 600 resolution). The experiment consisted of a thirst manipulation task, a modified go/no-go task, and a size perception task. After some general instructions and practice with the computer program, participants started with the experiment.

Manipulation of thirst

We manipulated thirst by adopting a manipulation developed by Aarts et al. (2001). In the thirst condition participants received a candy made of natural liquorice (product name Bisal) that weighed about three grams, and contained 14% salt. Aarts et al. showed that this candy substantially enhances thirst. Participants were asked to detect which letters were present on the candy. In the control condition, participants received a wine gum that did not contain any salt. After a 3 minute filler task participants started with the go/no-go task.

We tested this manipulation on an independent sample of participants ($N = 20$), and asked them after the candy task, to indicate, on a nine-point scale, how much they would like to drink a glass of a well-known brand of mineral water (i.e. Spa Blauw). Participants who consumed Bisal indicated that they wanted this water more ($M = 7.20$; $SD = 2.04$) than participants who consumed winegum ($M = 4.50$; $SD = 1.84$), $F(1, 18) = 9.63$, $p < .01$, $\eta^2 = .35$.

Go/no-go task

Next, participants received a go/no-go task (see Figure 1), which consisted of 50 trials. Each trial began with a pre-mask for 1000 ms, then either no stimulus or a bottle of water was presented for 30 ms, followed by a post-mask for 200 ms. Then, either a go or no-go cue (the letters p and f) was presented for 1000 ms or until the participant responded. Participants were asked to press the space bar when a go cue would appear on screen, and to refrain from responding when a no-go cue would appear. We counterbalanced instructions (e.g. react to “p” and not to “f”) across participants. When the participant responded correctly a green circle was presented and when the participant responded erroneously a red cross was presented. The intertrial interval was 1000 ms.

After 10 warm-up trials with no prime, including five go cues and 5 no-go cues, participants received 40 experimental trials. In the go condition the bottle of water was presented 10 times followed by a go cue, and in the no-go condition the bottle of water was presented 10 times followed by a no-go cue. In the remaining 30 trials no stimulus was presented between the pre- and post-mask. In total, participants received 20 go and 20 no-go experimental trials. Selection of a specific trial type (bottle present vs no stimulus, and go cue vs no-go cue) was random with the constraints that every four trials each trial type was presented once.

To ensure that the bottle would not enter conscious awareness we carefully constructed a mask, which contained a highly softened version of the original stimulus, and information was added in such a way that the bottle became unrecognizable (see Figure 1). This mask immediately preceded and followed presentation of the bottle (or no stimulus). To further ensure that the bottle would not be detected consciously we presented the picture of the bottle in the go/no-go task with softened angles (see Figure 1).

To examine whether the mask indeed prevented conscious recognition of the bottle we presented an independent sample of participants (N = 35) with the masked bottle for 20 trials, and asked them whether they could indicate which stimulus had been presented (see Bargh & Chartrand, 2000). None of the participant named the stimulus, i.e. Spa Blauw, or any other stimulus related to water. In the current experiment we checked participants for awareness during debriefing, and participants were also unaware of the primes. Thus, if effects of pairing water with go/no-go cues are found they seem to operate outside of awareness.

Size perception task

The size perception task was closely modelled after the one used by Veltkamp et al. (in press). Participants were told that their task was to estimate the size of objects, *as they were presented on the screen,* by indicating how tall the objects were in centimetres. We provided an example and three filler pictures in the very beginning of the experiment (a closet, lamp, and candle) to familiarize participants with this task before getting to the target stimuli, and to control for individual differences.

After the go/no-go task participants were reminded of the instructions of the size estimation task, and subsequently received the picture of the bottle of water (this time without any modification), and the picture of a glass of water. Participants could type in their estimate in centimetres (see Veltkamp et al., in press). Because in the Netherlands asking for Spa Blauw is equivalent to asking for a glass of (still) mineral water, this picture was included to increase reliability (r = .715). Both pictures were approximately 70 by 200 pixels in size.

Results

Participants hardly made errors in the go/no-go task (1.36 %). To examine whether co-occurrence of no-go cues and a bottle of water would decrease the perceived size of objects that represent water, we performed an analyses of variance (ANOVA) with thirst (no vs. yes), and pairing of the bottle of water (go condition vs. no-go condition) as between subjects factors, and the averaged size estimates of the water objects as dependent variable. In addition, we included the averaged size estimates of the three filler trials (from the beginning of the experiment) as covariate to control for individual differences in size estimations. This analyses yielded the predicted interaction between thirst and pairing, $F(1, 61) = 10.63$, $p < .01$, $\eta_p^2 = .15$ (see Figure 2).

Follow-up analyses revealed that when water was paired with go cues, thirsty participants perceived water objects as larger compared to non-thirsty participants, $F(1, 61) = 6.95$, $p < .05$, $\eta^2 = .10$. This result replicates earlier work by Veltkamp et al. (in press), and shows that rewarding objects are perceived as larger. Importantly, thirsty participants perceived water objects as smaller when water had been paired with no-go cues, than when water had been paired with go cues, $F(1, 61) = 13.60$, $p < .01$, $\eta^2 = .18$. This difference was not reliable for non-thirsty participants, $F(1, 61) = 1.01$, $p = .31$, $\eta^2 = .01$. Finally, thirsty participants perceived water objects as smaller when water was paired with no-go cues compared to non-thirsty participants, $F(1, 61) = 4.27$, $p < .05$, $\eta^2 = .07$.

Discussion

Results show that reward value of an object is decreased when this object is followed by cues that put behavior on hold. This finding points to an effective regulatory mechanism that decreases prioritization of potentially instrumental objects that are (temporarily) inappropriate to act on in the context at hand (see also Fenske & Raymond, 2006). Because the object was presented subliminally, it extends previous research by showing that this regulation occurred outside of awareness (cf. Aarts, Custers, & Holland, 2007).

In the no-go conditions, thirsty participants perceived water objects as smaller than non-thirsty participants. Because previous research has shown that linking objects to negative affect does not result in smaller size perceptions (Veltkamp et al., in press), it is unlikely that this reflects a negative evaluation of water objects. Consistent with Veling, Holland, et al. (2008), we think that when an object is so rewarding that it prepares a behavioral impulse, withholding behavior leads to a response conflict, and hence to attenuation of the value of such objects. This regulation is unnecessary for slightly rewarding objects (e.g. water for non-thirsty participants) that do not prepare behavior. When we compare the attenuation of reward value for thirsty participants with a (possibly) slightly positive baseline, an effect below baseline can be found. Importantly, the present data indicate that a decrease in perceived size only occurs when an impulse toward a rewarding object is put on hold, which renders that object less likely to be identified (Bruner, 1957).

Whereas the exact mechanism that causes differences in size perception has still to be delineated, work in neuroscience suggests that increased perceived size can be attributed to more allocation of processing resources (i.e. brain cells) to goal-relevant objects in the visual cortex (e.g. Desimone & Duncan, 1995; Serencis & Yantis, 2006). This may influence perceived size, and facilitate detection of such objects when they are goal-relevant. The present research suggests that putting behavior on hold in the presence of rewarding objects spontaneously attenuates the rewarding relevance of the objects, and hence, gives these objects less priority for allocating processing resources. This way detection of the unattainable object is hampered, and detection of other, attainable, objects facilitated.

In the present research we designed our task so that participants consistently (i.e. ten times) withheld a response towards an object, and we measured size perception immediately after this task (i.e. with minimal intervening instructions). Therefore, the size estimates reflect an almost online value-assessment of the objects. An interesting question for future research is whether attenuation of reward value decreases over time, or when the situation changes, in order to seize upon new opportunities, as decreasing the value of a specific means does not satisfy the need.

The present research offers new insight into the emergence of behavior regulation by showing that behavior-hold signals accompanying rewarding objects can nonconsciously modulate behavior towards these objects by decreasing the value of these objects that would otherwise be instrumental in reducing a need. As such, the present research elucidates an instance of behavior regulation that operates without conscious will.

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Author Note

Harm Veling, Department of Psychology, Utrecht University, The Netherlands; Henk Aarts, Department of Psychology, Utrecht University, The Netherlands.

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Correspondence concerning this article should be addressed to Harm Veling, Department of Psychology, Utrecht University, PO BOX 80140, 3508 TC Utrecht, The Netherlands. E-mail: h.veling@uu.nl

Figure captions

Figure 1. Outline of a trial in the go/no-go task where the bottle of water is primed.

Figure 2. Adjusted means of size estimates of objects representing water as a function of thirst and pairing of the bottle of water. Error bars represent the standard error.

Figure 1

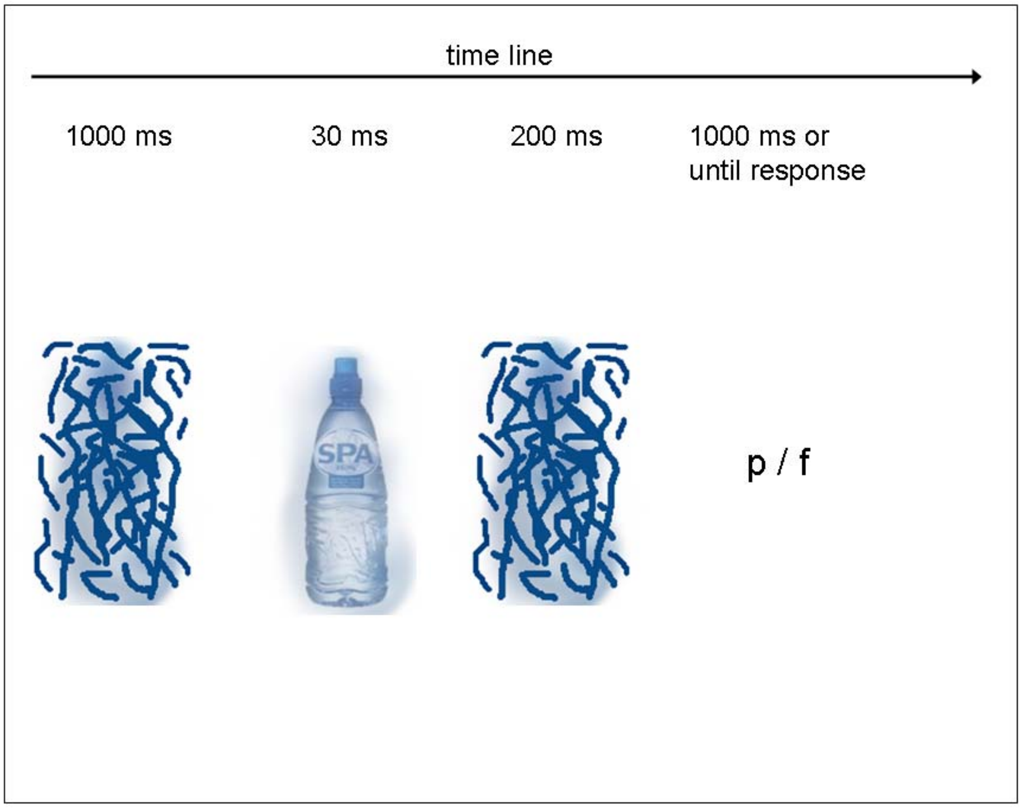
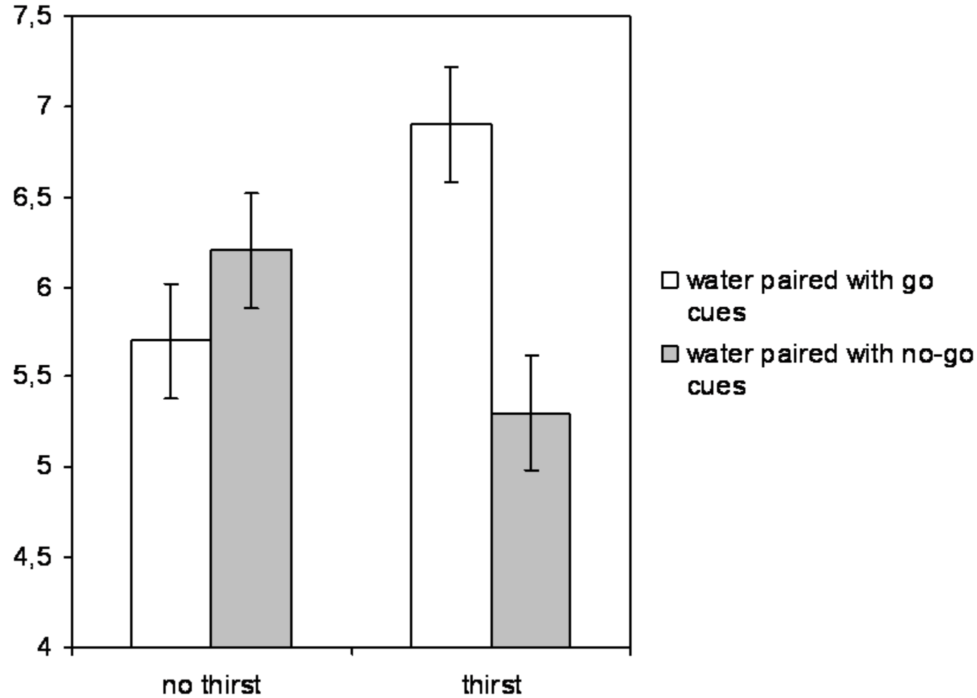


Figure 2



7,5
7
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6
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4
no thirst
thirst
water paired with go cues
water paired with no-go cues